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Design of a Tri-band Slotted Circular Microstrip Antenna with Improved Bandwidth for Wideband Applications

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Abstract

This paper presents a tri-band rectangular slotted circular micro strip antenna for wideband applications. The antenna operates at 2.96, 6.42 and 7.33 GHz frequency bands for VSWR<1 with an improved impedance bandwidth of 41.23%. The antenna has been designed and simulated on an FR4 substrate with dielectric constant (ε_r) of 4.4 with an overall size of 50 × 40 × 3.5 mm^3. The study of bandwidth improvement is presented in this paper by introducing the slots on surface of circular patch. The measured bandwidths for -10 dB reflection coefficient are 410 MHz (2.80-3.21 GHz) and 3.07 GHz (5.91-8.98 GHz). The simulated results show that the proposed antenna provides good performance in term of return loss and radiation pattern for wideband applications.

Keywords: *Tri-band, Patch antenna, Bandwidth improvement, Return loss, Radiation pattern*

1. Introduction

Microstrip patch antennas have been worked out extensively due to the advantages of compactness, light weight, and easiness to fabricate [1] however micro strip antennas suffer from an inherent limitation of narrow impedance bandwidth. Researchers have offered numerous methods like aperture coupling [2], stacked patch [3], modifications in the feed [4], staggering effect [5] to enhance the bandwidth of microstrip antennas [6]. However all these techniques make the design of the antenna more complex. Recently, tri-band antennas gained attention as they can be used for various applications including Wi-Max [7].

In the present work, a Tri-band Slotted Circular Micro strip Antenna [8] is proposed. This antenna resonates at 2.96, 6.42 and 7.33 GHz, which can be used for wideband [9] applications. In section 2, the proposed antenna geometry and the effect of introducing slots [10] on the proposed antenna are discussed and in section 3, the simulation results are presented.

2. Antenna Design

The design of the antenna begins with a circular micro strip antenna with patch radius 12 mm. The substrate chosen for the proposed antenna is FR-4 epoxy with dielectric constant, ε_r= 4.4 and a thickness of 3.5 mm. Three rectangular slots with sizes of 16.5 mm × 1 mm and 11 mm × 1 mm and 6 mm × 1 mm were made on the circular patch antenna. The dimensions of the substrate are taken as 50 × 40 × 3.5 mm^3 and the size of the ground plane is taken as 50 × 40 mm^2. The geometry of proposed microstrip patch antenna is shown in Fig 1. All the dimensions are in mm.

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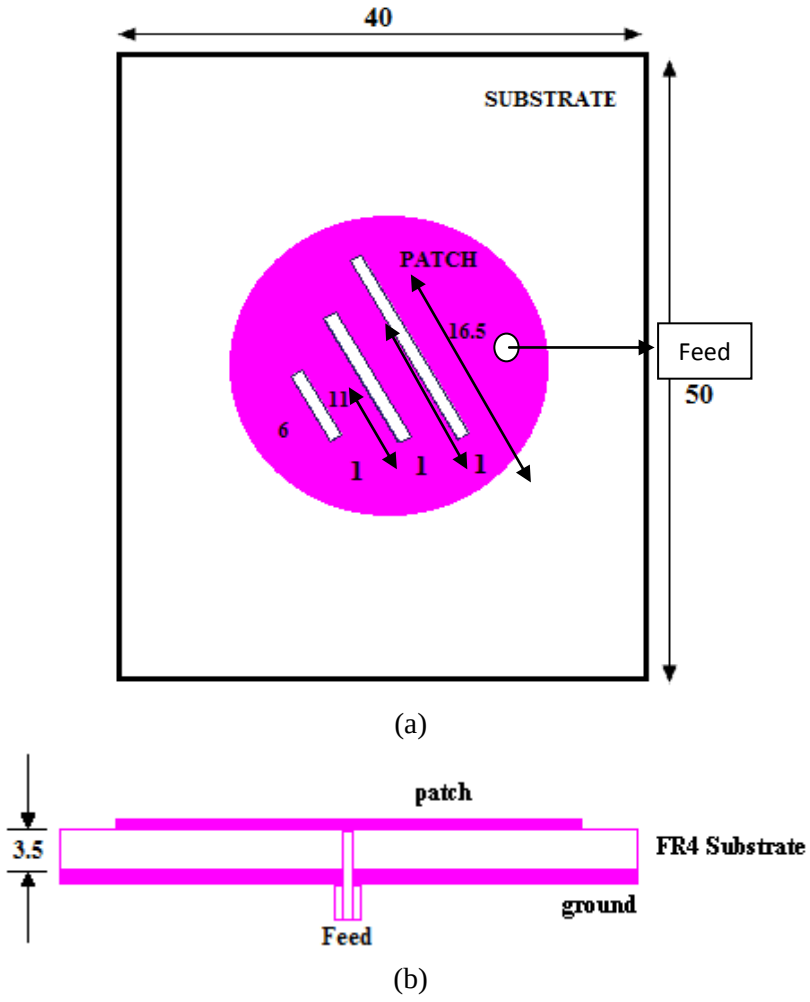


Figure 1. Proposed Microstrip Patch Antenna (a) Top View (b) Side View

Microstrip patch antennas can be fed by a variety of methods. These methods are classified into two categories which are contacting (direct) and non-contacting. The four most popular feeding techniques used are microstrip feed; co-axial probe feed, aperture coupled and proximity coupled feeding. Here the whole system is fed by a co-axial probe.

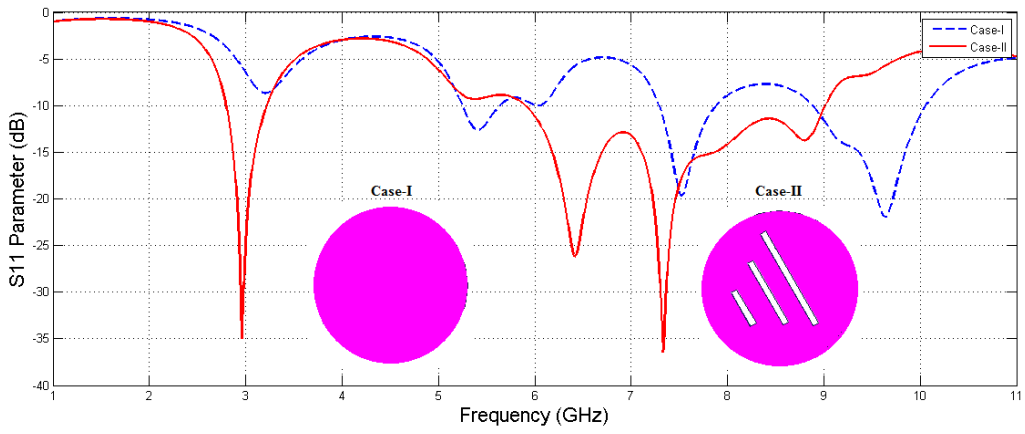


Figure 2. The Effect of Introducing Slots on the Proposed Antenna

Initially we consider the circular microstrip patch antenna without any slots. It has very poor performance in terms of bandwidth and return loss. It is considered as case1. By introducing the rectangular slots on the circular microstrip patch antenna the tri-band is achieved with bandwidth of 3.07 GHz including middle and upper bands. The effect of introducing these slots on the proposed antenna is shown in Figure 2.

3. Results

The simulation results for the proposed antenna are shown in the figures below. The return loss is shown in Figure 3. The antenna resonates at frequency 2.96, 6.42 and 7.33 GHz with a return loss of 37.24 db, 25.50 db and 38.99 db respectively. The measured bandwidths for -10 dB reflection coefficient are 410 MHz (2.80-3.21 GHz) and 3.07 GHz (5.91-8.98 GHz). The VSWR plot is shown in Figure 4. The VSWR values are 0.23, 0.92 and 0.24 for corresponding three resonant frequencies indicating the good matching conditions with triple band frequencies. The radiation patterns at 2.96, 6.42 and 7.33 GHz for $Ø = 0^0$ & 90^0 are shown in Figure 5.

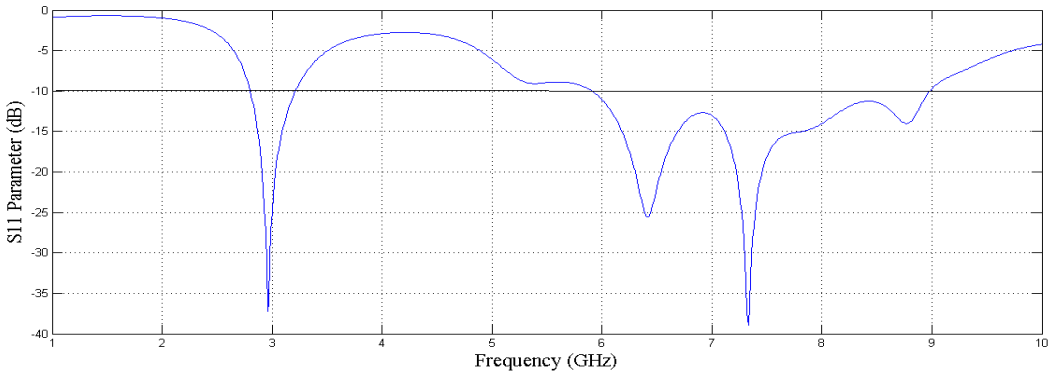


Figure 3. Return Loss of the Proposed Antenna

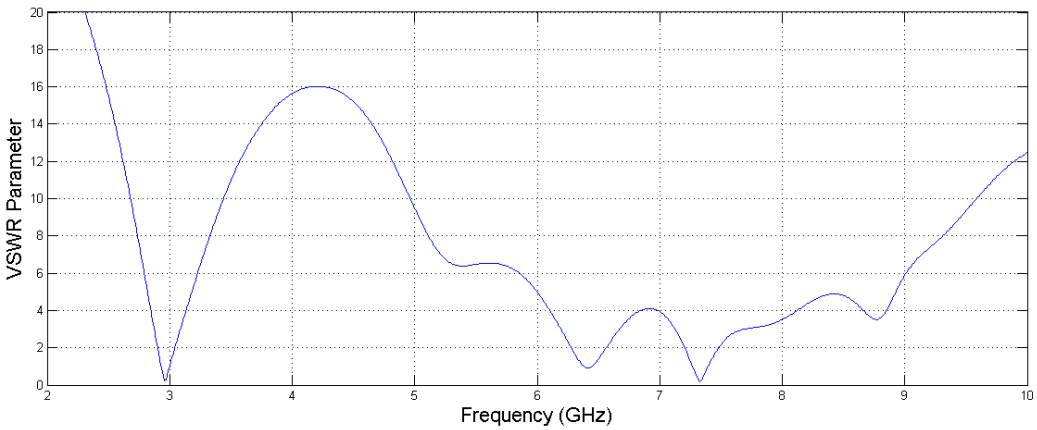
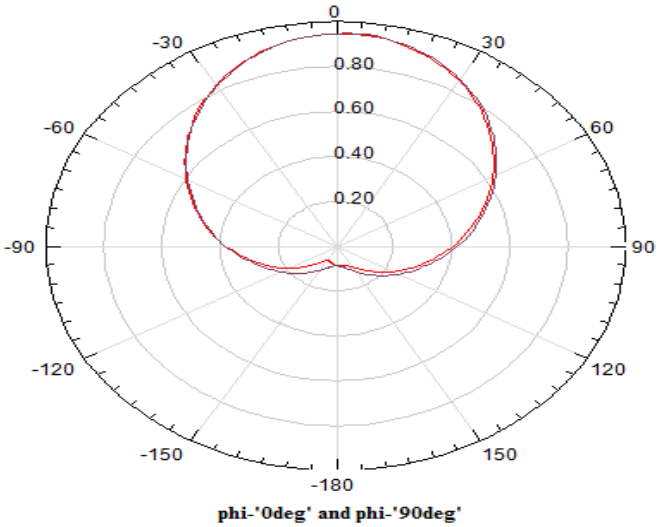
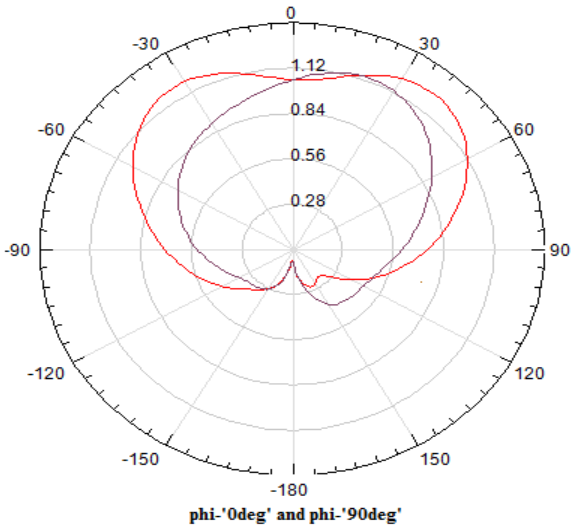


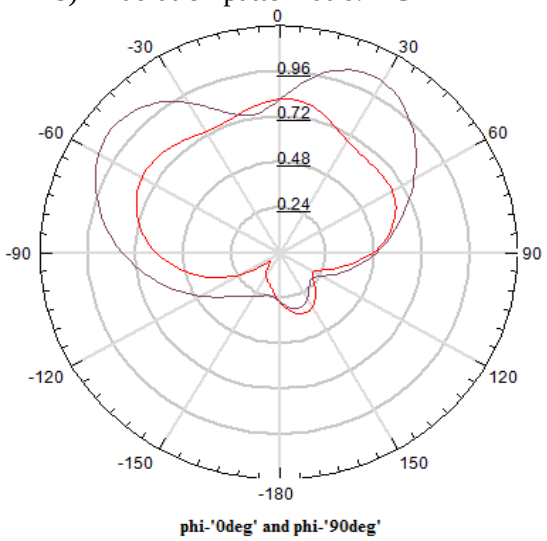
Figure 4. VSWR Plot of the Proposed Antenna



a) Radiation pattern at 2.96GHz



b) Radiation pattern at 6.42GHz



c) Radiation Pattern at 7.33GHz

Figure 5. Radiation Patterns of the Proposed Antenna

4. Conclusion

This paper presents a tri-band slotted circular microstrip antenna for wideband applications.The proposed antenna has a compact size of 50mm x 40mm. The antenna operates at 2.96, 6.42 and 7.33 GHz frequency bands for VSWR<1 with an improved impedance bandwidth of 41.23%. The study of bandwidth improvement is presented in this paper by introducing the slots on surface of circular patch. The simulated results show that the proposed antenna provides good performance in term of return loss and radiation pattern for wideband applications.

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